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**3.1 Using and Expressing Measurements**

**IDX G9 CHEMISTRY S STUDY GUIDE**

**ISSUE 4**

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I. Scientific Notation

* A measurement is a quantity that has both a number and a unit.
* 𝑚×10^𝑛  𝑚: coefficient(1≤𝑚<10) 𝑛:exponent
* 304,000,000=3.04×107304,000,000=3.04×10^7← no decimal points, count from right to left, significant figures are 304
* 30,400,000.=3.0400000×10730,400,000.=3.0400000×10^7 ← with decimal points, count from left to right
* Addition/Subtraction: exponents must be the same
* Multiplication: multiply the coefficients and add the exponents
* Division: divide the coefficients, subtract the exponent in the denominator from the exponent in the numerator

II. Accuracy and Precision

* Accuracy is a measure of how close a measurement comes to the actual or true value of whatever is measured
* Precision is a measure of how close a series of measurements are to one another, irrespective of the actual value
* Possible outcomes: 1. Good accuracy, good precision

2. Poor accuracy, good precision

3. Poor accuracy, poor precision

4. Good accuracy, poor precision (not often and possible)

* Reliable Results should be both highly precise and accurate
* Give about the same result again and again; close to accepted value

III. Error

* Error is the difference between the experimental value and the accepted value
* Error – exponential value ---- accepted value
* Percent error of a measurement is the absolute value of the error divided by the accepted value, multiplied by 100%
* Percent error = | error | / accepted value · 100%

IV. Significant Figures

* Calculation depend on number of significant figures
* Counting significant figures:
* If decimal point is present, start counting from the first non-zero digit from left to right till the end
* If the decimal point is absent, start counting from the first non-zero digit from right to left till the end
* Exact defined values or counting numbers have an unlimited number of significant figures

V. Significant Figures in calculation

* Rounding off: less than 5 then round down, greater than or equal to 5 then round up
* Addition/Subtraction: result has same number of decimal place as the measurement with fewest decimal place
* Multiplication/Division: result has same significant figure as fewest significant figure of numbers before “=”
* For multi-step calculation, round the intermediate result

**3.2 Units of Measurement**

* 7 Base Units

Physics quantity Unit symbol

Mass Kilogram-kg

Length Meter-m

Time Second-s

Temperature Kelvin-k

Amount of substance Mole-mol

Electric current Ampere-A

Luminous intensity Candela-Cd

* Common Prefixes

Prefix Symbol Factor

Mega M 10^6

Kilo k 10^3

Deci d 10^-1

Centi c 10^-2

Mili m 10^-3

Micro μ 10^-6

Nano n 10^-9

Pico p 10^-12

* Volume
* 1L = 1dm^3
* 1ml = 1cm^3
* 1L = 1000mL
* Mass
* 1 gram is the mass of 1 cm^3 of water at 4 degreed Celsius
* W = m · g
* Energy
* The capacity to do work or to produce heat
* SI unit is Joule
* Common non-SI unit is calorie
* 1J = 0.2390 calorie
* Temperature
* A measure of how hot or cold an object is
* Celsius, Kelvin
* K = degrees Celsius + 273 Degrees Celsius = K – 273
* The zero point on kelvin Scale, or absolute zero, is equal to -273.15 degrees Celsius
* Density
* The ratio of the mass of object to its volume
* Density = Mass / Volume
* SI unit is kg/m^3

**3.3 Solving Conversion Problems**

* A conversion factor is a ratio of equivalent measurements
* Pattern: smaller number + larger unit

Larger number + smaller unit

* Conversion factors are defined quantities or exact quantities
* Unlimited number of sf

**5.3 (5.1) Revising the Atomic Model**

* The Bohr Model
* Electrons move in certain circular orbits with allowed energy state around the nucleus designated by a quantum number n (n=1,2,3…)
* Louis de Broglie
* Particles of matter should behave like waves and exhibit a wavelength, just as waves of light behave like particles of matter
* The Heisenberg Uncertainty Principle
* The position and velocity of a moving object cannot be measured and known at the same time
* The Quantum Mechanical model
* Determines allowed energies an electron can have and the probability to find the electron in various locations around the nucleus of an atom
* An atomic orbital is represented pictorially as a region of space in which there is a high probability of finding an electron

Atomic Orbitals

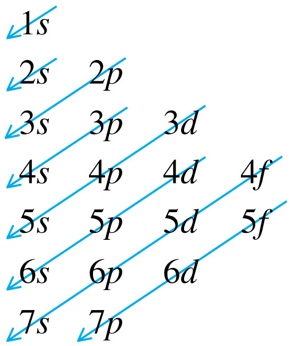
* Represented by letters: s, p, d, f (also called sublevels)
* Each principle energy level (n) has n sublevels
* Each sublevels have differ orbitals: s-1, p-3, d-5, f-7
* Each energy level (n) consists of n^2 orbitals
* A maximum of two electrons can occupy an orbital
* Maximum number of electrons of a principle energy level is 2n^2

**5.2 Electron Arrangement in Atoms**

* Electron configurations: the ways in which electrons are arranged in various orbitals around the nuclei of atoms
* Determines the chemical properties of elements and it’s origin of periodic trends
* The most stable arrangement of the electrons of the electrons, which indicate ground state of the atom

I. Aufbau Principle

* Electrons occupy orbitals of lowest energy first

图表, 箱线图

描述已自动生成

Energy ranking:

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f 6d 7p

II. Pauli Exclusion Principle

* An atomic orbital may describe at most two electrons with opposite spins
* Spin is a quantum mechanical property of electrons and may be thought of as clockwise or counterclockwise
* Paired: opposite spin electrons occupy an orbital

Unpaired: a single electron in one orbital

图表

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III. Hund’s Rule

* Electrons occupy orbitals of the same energy in a way that makes the number of electrons with the same spin direction as large as possible

图表, 图示

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IV. Condensed Electron Configurations

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* Noble gas: most stable element
* Ex. Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr)
* Ground state is the most stable, lowest energy state of the atom
* Carbon: ground state: 1s^2 2s^2 2p^2

Excited state: 1s^2 2s^2 2p^1 3s^1

* Exceptional: 文本

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* some actual electron configurations differ from those assignments using the Aufbau principle because although half-filled sublevels are not as stable as filled sublevels, they’re more stable than other configurations

**6.1 Organizing the Elements**

I. Searching for an Organizing Principle

* as chemists began to use scientific methods to search for elements, the rate of discovery increased
* in one decade (1765-1775), chemists discovered 5 new elements
* in 1790s, Lavoisier made a list of 23 elements
* early chemists used the properties of elements to sort them into groups
* Law of Triads (group of three)
* The elements in a triad have similar chemical properties
* Law of Octaves (groups of eight)
* When these elements were arranged in order of increasing atomic mass, the properties every eight elements

II. Mendeleev’s Periodic Table

* Mendeleev arranged the elements in his periodic table in order of increasing atomic mass
* He arranged elements with similar properties in the same row
* He predicted that element would be discovered to fill those spaces, and what their properties would be based on their location in the table

III. Today’s Periodic Table

* Periodic Law: when elements are arranged in order of increasing atomic number, there’s a periodic repetition of their physical and chemical properties
* H.G.J.Mosely determined an atomic number for each known element
* In modern periodic table, elements are arranged in order of increasing atomic number
* 7 rows / periods
* 18 groups / families
* Mendeleev found correct pattern ever he arranged the elements according to the wrong property
* Atomic masses generally increases according to the atomic number
* Element No. 101 is named after Mendeleev for his contribution to chemistry图示, 日程表

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IV. Metals, Nonmetals, and Metalloids

* Across a period, the properties of elements become less metallic and more nonmetallic
* Down a group, the properties of elements become less nonmetallic and more metallic

Metals

* Luster of shine, which is caused by the metal’s ability to reflect light
* Good conductor of heat and electricity
* Solid at room temperature (except Hg)
* Malleable (can be hammered into thin sheets without breaking) and ductile (can be drown into wires)
* Sopper is second only to silver as a conductor of electric current
* Aluminum is one of the metals that can be shaped into a think sheet, or foil

Nonmetals

* There’s a greater variation in physical properties among nonmetals than among metals
* Most are gas at room temperature, including nitrogen + oxygen
* A few are solids, such as sulfur and phosphorus
* Bromine, is a dark-red liquid
* Usually gas or brittle solids
* Solids are dull in appearance
* Poor conductors of heat and electricity (graphite is an exception)

Semimetals (metalloids)

* Slight luster
* Conduct electricity at high temperature
* Brittle
* The behavior can often be controlled by changing the conditions

**6.2 Classifying the Elements**

I. Reading the periodic Table

Periods: horizontal rows in the table, whose properties change gradually and predictably

Groups (families): vertical columns in the table, in which elements have similar properties

图示, 示意图

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表格

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Black: solid at room temperature

Red: gas at room temperature

Liquid: liquid at room temperature

Gray: not found in nature

* Period 1-3: shorter period (2,8,8) elements
* Period 4-5: longer period (18,18) elements
* Period 6-7: 32 elements now

日历

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* Totally 7 periods, 18 groups now
* The International Union of Pure and Applied Chemistry (IUPAC) is an organization that sets standards for chemistry
* Not widely adopted

图表, 条形图

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II. Electron Configurations in Groups

* Electrons that occupy the highest principal energy level are the atom’s outmost electrons
* Valence electrons are involved in chemical bonding
* Valence electrons are largely responsible for an atom’s chemical behavior
* For lighter element (atomic number < 30), all outmost electrons are valence electron
* The periodic table is structured so that elements with the same pattern of outmost level electron configuration are arranged in columns
* The periodic table is divided into four section ---- s, p, d, f block
* 2-column s-block and 6-column p-block elements are the representatives elements
* The 10-column d-block elements are transition elements
* The 14-column f-block elements are the inner transition elements (lanthanides and the actinide elements)
* Representative Elements:
* Most are solids, few gas at room temperature, bromine is the only liquid
* S-block: elements = hydrogen and helium and Group 1A and Group 2A
* P-block: elements = Group 3A – Group 8A (except He)
* Group number equals the number of electrons in the highest occupied energy level
* Transition elements:
* D-block: elements = Group 1B – Group 8B (group 3 – group 12)
* F-block: elements = lanthanide series, actinide series
* Classify elements based on electron configuration of highest occupied energy level
* Representative elements:

S or P sublevel are only partially filled

ns^1 -ns^2, ns^2p^1 – ns^2np^6

* Transition metals:

S sublevel and nearby d sublevel contain electrons

(n-1)d^1ns^2 – (n-1)d^10ns^2

* Inner Transition Metals:

S sublevel and nearby f sublevel contain electrons

(n-2)f^1ns^2 – (n-2)f^14ns^2